Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Loads and Dynamics Harmonization Working Group

Task 13 – Revise Gust Load Design Requirements

Task Assignment

[Federal Register: April 13, 1995 (Volume 60, Number 71)]
[Notices]
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DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues--New Task

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of a new task assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT:
Stewart R. Miller, Manager, Transport Standards Staff, ANM-110, **FAA**, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Ave. SW, Renton, WA 98055-4056, telephone (206) 227-2190, fax (206) 227-1320.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the **FAA** Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the **FAA**'s rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the **FAA**'s commitment to harmonize its Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is transport airplane and engine issues. These issues involve the airworthiness standards for transport category airplanes in 14 CFR parts 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135.

The Task

This notice is to inform the public that the **FAA** has asked ARAC to provide advice and recommendation on the following harmonization task:

Recommend disposition of public comments made to Notice of Proposed Rulemaking No. 94-29, which proposed to revise the gust load design requirements for transport category airplanes, and provide for harmonization of the discrete gust requirements with the Joint Aviation Requirements (JAR) of Europe as recently amended.

Contrary to the usual practice, the **FAA** is not asking ARAC as part of this task to develop a final draft of the next action (i.e., supplemental notice, final rule, or withdrawal). However, ARAC must provide a document setting forth the rationale for the recommended disposition of each of the comments.

ARAC Acceptance of Task

ARAC has accepted the task and has chosen to assign it to the existing Loads and Dynamics Harmonization Working Group. As a result of the new task assigned to the working group, membership is being reopened. The working group will serve as staff to ARAC to assist ARAC in the analysis of the assigned task. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts the working group's recommendations, it forwards them to the **FAA** as ARAC recommendations.

Working Group Reports to ARAC

The Loads and Dynamic Harmonization Working Group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a work plan for completion of the tasks, including the rationale supporting such a plan, for consideration at the meeting of ARAC to consider transport airplane and engine issues held following publication of this notice.
2. Give a detailed conceptual presentation of the proposed recommendations, prior to proceeding with the work stated in item 3 below.
3. For each task, draft appropriate regulatory documents with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations.
4. A status report at each meeting of ARAC held to consider transport airplane and engine issues.

Participation in the Working Group

The Loads and Dynamic Harmonization Working Group is composed of experts from those organizations having an interest in the assigned task. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the tasks, and stating the expertise he or she would bring to the working group. The request will be reviewed by the assistant chair, the assistant executive director, and the working group chair, and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

Meetings of ARAC will be open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the Loads and Dynamics Harmonization Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on April 10, 1995.
Chris A. Christie,
Executive Director, Aviation Rulemaking Advisory Committee.
[FR Doc. 95-9154 Filed 4-12-95; 8:45 am]
BILLING CODE 4910-13-M

Recommendation Letter

Gerald R. Mack
Director
Certification &
Government Requirements

Boeing Commercial Airplane Group
P.O. Box 3707, MS 67-UM
Seattle, WA 98124-2207

May 26, 1995
B-T01B-ARAC-95-005

Mr. Anthony J. Broderick (AVR-1)
Associate Administrator for Regulations and Compliance
Department of Transportation
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington DC 20591

BOEING

Subject: Recommendations for Disposition of Comments to the Proposal for Discrete Gust Design Loads

Reference: Loads & Dynamics Harmonization Working Group - Transport Airplane and Engine Issues Group, ARAC

Dear Mr. Broderick:

Enclosed are the subject recommendations for disposition of comments on NPRM 94-29 (discrete gust design loads).

We appreciate the opportunity to review and to propose a disposition on these comments.

Sincerely,

Gmack

Gerald R. Mack
Assistant Chairman
Transport Airplane & Engine Issues Group
Aviation Rulemaking Advisory Committee

Enclosure

Acknowledgement Letter

NOV 24 1993

Mr. Dale S. Warren
Assistant Chair for Transport Airplane
and Engine Issues
Aviation Rulemaking Advisory Committee
Long Beach, CA 90804

Dear Dale:

Thank you for your October 15 letter with which you transmitted a recommendation of the Aviation Rulemaking Advisory Committee. You provided a notice of proposed rulemaking (NPRM) concerning revised discrete gust load design requirements. The Federal Aviation Administration (FAA) accepts this recommendation provided there are no legal or other reasons why we cannot adopt it.

The complete rulemaking package will be reviewed and coordinated within the FAA and the Offices of the Secretary of Transportation and Management and Budget. The FAA will publish the NPRM for public comment as soon as the coordination process is complete. We will make every effort to handle this recommendation expeditiously.

I would like to thank the Aviation Rulemaking Advisory Committee, and particularly the Loads and Dynamics Harmonization Working Group, for its action on this task.

Sincerely,

Anthony J. Broderick
Associate Administrator for
Regulation and Certification

Recommendation

Subject: Recommendations for disposition of comments to the proposal for discrete gust design loads.

The Aviation Regulatory Advisory Committee (ARAC) submitted recommendations for the harmonization of the discrete gust design loads requirements to the FAA by letter dated October 15, 1993. The FAA concurred with the recommendations and proposed them in Notice of Proposed Rulemaking (NPRM) No. 94-29 which was published in the Federal Register on September 16, 1994, (59 FR 47756).

Comments were received by the FAA from foreign and domestic aviation manufacturers and foreign airworthiness authorities Many of these comments were supportive of the proposal, while some suggested substantive changes. The FAA tasked the ARAC Loads and Dynamics Working Group (LDHWG) by notice in the Federal Register (60 FR 18874, April 13, 1995) to consider the comments and provide recommendations for their disposition

In accordance with the assigned task the LDHWG has discussed the public comments and developed recommended dispositions. The comments and their dispositions have generally been grouped into the four categories listed below and are provided for use in responding to the public comments.

1) <u>Supportive comments</u>. Several commenters supported the proposal and recommended that it be promulgated as proposed

2) <u>Editorial error in the formula for the design speed for maximum gust intensity V_B</u> Several commenters correctly identified an editorial error in the formula for V_B and it has been corrected.

3) <u>The criteria for establishing V_B is unconservative</u>. One commenter believes that the new criteria for V_B is unconservative and could provide unrealistic margins above the stalling speed. The commenter suggests that the criteria of the current JAR-25 be used instead. The FAA disagrees. The commenter provided no data or other information that shows the new V_B calculations to be unrealistic. The new method for calculating the minimum V_B is approximately the same as in the current part 25 and JAR-25; the main difference being that the revised gust speeds are used in the calculation. These gust speeds are based on actual measurements in aircraft operation and are considered to result in a realistic and conservative V_B speed, even if it is somewhat lower than the current requirements at some altitudes. In addition, a new operational rough air speed, V_{RA} is provided in order to ensure adequate margins above the stalling speed while operating in rough air. As part of the effort to harmonize the airworthiness requirements, the JAA is proceeding with a proposal for calculating the minimum V_B speeds which is identical to the proposal in the Notice 94-29.

4) <u>The discrete gust methodology can under predict design loads in some cases</u>. One commenter suggested that the proposed tuned gust criteria does not fully account for the dynamic response of the airplane and therefore could produce unconservative gust design loads. The commenter suggested that the proposal be replaced by an entirely different method of accounting for discrete gusts. This method is known in the industry as the statistical discrete gust method (SDG). The LDHWG considered the commenters specific concerns and the alternate proposal in considerable detail. It is recognized by the working group that the current proposed tuned gust criteria has some limitations and that the suggested SDG method may have some promising features for predicting design gust loads. However, the SDG method is still in a developmental stage and there is currently no formally established industry process for using this method in predicting gust design loads. The FAA will retain the commenters proposal for additional study and possible consideration in future rulemaking actions. In response to this commenters specific concerns, neither ARAC nor the FAA agree that the tuned gust method will result in unconservative design loads. The commenter provided some comparisons of loads produced by the SDG method with the results of the proposed tuned gust method. These results were reviewed by the LDHWG and it was determined that they showed no significant differences in overall load levels when all factors were taken into account, and in some cases the SDG method could actually provide lower design loads. In addition, for establishing the overall design gust load level the proposed discrete gust criteria are complemented by the continuous turbulence criteria of Appendix G. For the longer gust gradient distances where the commenter questions the adequacy of the tuned gust method to fully account for dynamic response, the FAA believes that the additional criteria for continuous gusts directly compensates for any potential deficiencies in the discrete gust criteria of § 25.341(a).

In conclusion, except for a minor editorial change in the formula for V_B, the Aviation Regulatory Advisory Committee recommends that the FAA proceed with the rule as published in the NPRM.

FAA Action

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. 27902; Notice No. 94–29]

RIN 2120–AF27

Revised Discrete Gust Load Design Requirements

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of proposed rulemaking.

SUMMARY: This notice proposes to revise the gust load design requirements for transport category airplanes. The proposed changes would: (1) replace the current discrete gust requirement with a new requirement for a discrete tuned gust; (2) modify the method of establishing the design airspeed for maximum gust intensity; and (3) provide for an operational rough air speed. These changes are proposed in order to provide a more rational basis to account for the aerodynamic and structural dynamic characteristics of the airplane. These proposed changes would also provide for harmonization of the discrete gust requirements with the Joint Aviation Requirements (JAR) of Europe as recently amended.

DATES: Comments must be received on or before December 15, 1994.

ADDRESSES: Comments on this notice may be mailed in triplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC–200), Docket No. 27902, 800 Independence Avenue SW., Washington, DC 20591; or delivered in triplicate to: Room 915G, 800 Independence Avenue SW., Washington, DC 20591. Comments delivered must be marked Docket No. 27902. Comments may be examined in Room 915G weekdays, except Federal holidays, between 8:30 a.m. and 5 p.m. In addition, the FAA is maintaining an information docket of comments in the Transport Airplane Directorate (ANM–100), Federal Aviation Administration, 1601 Lind Avenue SW., Renton, WA 98055–4056. Comments in the information docket may be examined weekdays, except Federal holidays, between 7:30 a.m. and 4 p.m.

FOR FURTHER INFORMATION CONTACT: James Haynes, Airframe and Propulsion Branch, ANM–112, Transport Airplane Directorate, Aircraft Certification Service, FAA, 1601 Lind Avenue SW., Renton, WA 98055–4056; telephone (206) 227–2131.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to participate in this proposed rulemaking by submitting such written data, views, or arguments as they may desire. Comments relating to any environmental, energy, or economic impact that might result from adopting the proposals contained in this notice are invited. Substantive comments should be accompanied by cost estimates. Commenters should identify the regulatory docket or notice number and submit comments in triplicate to the Rules Docket address above. All comments received on or before the closing date for comments will be considered by the Administrator before taking action on this proposed rulemaking. The proposals contained in this notice may be changed in light of comments received. All comments received will be available in the Rules Docket, both before and after the comment period closing date, for examination by interested persons. A report summarizing each substantive public contact with FAA personnel concerning this rulemaking will be filed in the docket. Persons wishing the FAA to acknowledge receipt of their comments must submit with those comments a self-addressed, stamped postcard on which the following statement is made: "Comments to Docket No. 27902." The postcard will be date/time stamped and returned to the commenter.

Availability of NPRM

Any person may obtain a copy of this notice by submitting a request to the Federal Aviation Administration, Office of Public Affairs, Attention: Public Inquiry Center, APA–230, 800 Independence Avenue SW., Washington, DC 20591; or by calling (202) 267–3484. Communications must identify the notice number of this NPRM. Persons interested in being placed on a mailing list for future rulemaking documents should also request a copy of Advisory Circular No. 11–2A, Notice of Proposed Rulemaking Distribution System, which describes the application procedure.

Background

The National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA), began an inflight gust measurement program in 1933 to assist in the refinement of gust load design criteria. Using unsophisticated analog equipment, that program resulted in the development of the improved design requirements for gust loads that were issued in part 04 of the Civil Aeronautics Regulations (CAR) in the 1940's. The corresponding Civil Aeronautics Manual (CAM) 04 provided a simplified formula from which to derive the design gust loads from the specified design gust velocities. These criteria were based on an analytical encounter of the airplane with a discrete ramp-shaped gust with a gradient distance (the distance necessary for the gust to build to a peak) of 10 times the mean chord length of the airplane wing. An alleviation factor, calculated from wing loading, was provided in order to account for the relieving effects of rigid body motion of the airplane as it penetrated the gust. With the development of the VGH (velocity, load factor, height) recorder in 1946, NASA began collecting a large quantity of gust load data on many types of aircraft in airline service. Although that program was terminated for transport airline operations in 1971, the data provided additional insight into the nature of gusts in the atmosphere, and resulted in significant changes to the gust load design requirements. The evolution of the discrete gust design criteria from part 04 through part 4b of the CAR to current part 25 of Title 14 of the Code of Federal Regulations (CFR) (which contains the design requirements for transport category airplanes) resulted in the establishment of a prescribed gust shape with a specific gust gradient distance and increased peak gust design velocities. The prescribed shape was a "one-minus-cosine" gust shape with a specified gust gradient distance of 12.5 times the mean chord length of the airplane wing. The gust gradient distance, for that particular shape, was equal to one-half the total gust length. A simplified analytical method similar to the methodology of CAM 04 was provided along with an improved alleviation factor that accounted for unsteady aerodynamic forces, gust shape, and the airplane rigid body vertical response.

The increasing speed, size, and structural flexibility of transport airplanes resulted in the need to consider not only the rigid body response of the airplane, but also structural dynamic response and the effects of structural deformation on the aerodynamic parameters. Early attempts to account for structural flexibility led to a "tuned" gust approach in which the analysis assumed a flexible airplane encountering gusts with various gradient distances in order to find the most critical gust gradient distance for use in design for each major component.

A tuned discrete gust approach became a requirement for compliance with the British Civil Airworthiness Requirements.

Another method of accounting for the structural dynamic effects of the airplane involved the power spectral density (PSD) analysis technique which accounted for the statistical distribution of gusts in continuous turbulence in conjunction with the aeroelastic and structural dynamic characteristics of the airplane. In the 1960's, the Federal Aviation Administration (FAA) awarded study contracts to Boeing and Lockheed for the purpose of assisting the FAA in developing the PSD gust methodology into continuous gust design criteria with analytical procedures. The final PSD continuous turbulence criteria were based on those studies and were codified in Appendix G to part 25 in 1980.

Recognizing that the nature of gusts was not completely defined, and that individual discrete gusts might exist outside the normal statistical distribution of gusts in continuous turbulence, the FAA retained the existing criteria for discrete gusts in addition to the new requirement for continuous turbulence. The current discrete gust criteria in Subpart C of part 25 require the loads to be analytically developed assuming the airplane encounters a gust with a fixed gradient distance of 12.5 mean chord lengths. For application of the current criteria, it is generally assumed that the airplane is rigid in determining the dynamic response to the gust while the effects of wing elastic deflection on wing static lift parameters are normally taken into account. The minimum value of the airplane design speed for maximum gust intensity, V_B, is also established from the discrete gust criteria.

Recent flight measurement efforts by FAA and NASA have been aimed at utilizing measurements from the digital flight data recorders (DFDR) to derive gust load design information for airline transport airplanes. The Civil Aviation Authority (CAA) of the United Kingdom has also been conducting a comprehensive DFDR gust measurement program for transport airplanes in airline service. The program, called CAADRP (Civil Aircraft Airworthiness Data Recording Program), uses data sampling rates that allow the measurement of a wide range of gust gradient distances. The CAADRP program is still continuing and has resulted in an extensive collection of reliable gust data.

In 1988, the FAA, in cooperation with the JAA and organizations representing the American and European aerospace industries, began a process to harmonize the airworthiness requirements of the United States and the airworthiness requirements of Europe in regard to gust requirements. The objective was to achieve common requirements for the certification of transport airplanes without a substantive change in the level of safety provided by the regulations. Other airworthiness authorities such as Transport Canada have also participated in this process.

In 1992, the harmonization effort was undertaken by the Aviation Regulatory Advisory Committee (ARAC). A working group of industry and governmental structural loads specialists of Europe, the United States, and Canada was chartered by notice in the **Federal Register** (58 FR 13819, March 15, 1993). The harmonization effort has now progressed to a point where some specific proposals have been developed by the working group for the discrete gust requirements and these proposals have been recommended to FAA by letter dated October 15, 1993. The FAA is also considering other proposals for future rulemaking.

Discussion

The continued evolution of gust design requirements among the various world aviation authorities has resulted in many separate gust load design criteria with which the transport airplane manufacturer must comply in order to export its product. Recent efforts between the FAA and the Joint Aviation Authorities (JAA) of Europe in cooperation with the transport manufacturers has resulted in a proposal to refine the criteria and consolidate them into a common set of gust requirements. A review was made of analytical methods to find a single method that would simulate both discrete gusts and continuous turbulence and produce design loads that could be used directly for structural analysis. However, no single method was found to be satisfactory for accounting for both the discrete gust and continuous turbulence; therefore, separate criteria for these conditions will be retained in the requirements. This notice addresses only the discrete gust criteria. If revisions to the continuous turbulence criteria are deemed necessary, they will be proposed in a future notice.

A tuned discrete gust methodology would replace the current discrete gust requirement of § 25.341 in order to provide a more rational basis that accounts for the aerodynamic and structural dynamic characteristics of the airplane. This methodology would take into account the expected operation of the airplane by allowing multiplying factors, based on fuel loading and maximum operating altitude, to be used to adjust the required design gust velocities. This method is considered to be more rational in that it more accurately reflects the actual conditions experienced by the airplane and is therefore less likely to lead to either overdesigning or undesigning of structure. An effort has been undertaken by the industries and governments of the United States and Europe to evaluate the new proposed criteria and ensure that the provide reasonable design loads for current conventional transport airplanes as well as for new technology airplanes that may include systems that react in a nonlinear manner. Furthermore, the proposed gust gradient distance and design gust velocity distributions are believed to represent the best available measurements of the gust environment in which the airplane is likely to be operated. In this regard, the CAADRP gust measurement data (CAA, Safety Regulation Group, Research Note Number 74, November 30, 1990, "Investigation of Derived Gust Velocities from CAADRP Data") have been used to support the design gust velocity and gradient distance distributions for the new proposed discrete gust design criteria.

The method for establishing the minimum value of the design speed for maximum gust intensity, V_B, which is currently predicated on the discrete gust criteria of the current § 25.341, would also be revised. The proposed tuned gust criteria would replace the static discrete gust criteria of § 25.341 which are used in the calculation of the minimum value of V_B. Therefore, a revised criterion for the minimum V_B is also proposed.

The proposal does not include a discrete gust design condition at V_B, although the speed V_B would continue to be used in determining the criteria for continuous turbulence. The design gust velocity and gradient distances established for the gust design conditions at V_C, "structural design cruising speed," and V_D, "structural design diving speed," were developed in consideration of the full operational envelope so that a specific discrete gust condition at V_B is not considered necessary, provided an adequate speed margin is retained between V_B and V_C, and provided the current practices for operating in severe turbulence are continued. In this regard, it is also proposed that the recommended operational turbulence penetration speed of § 25.1585(a)(8) be based on a new operational rough air speed, V_{RA}, which would be no greater than the V_B chosen for structural design. In the interest of developing a common requirement for part 25 and JAR–25, the current JAR requirement (JAR 25.1517) for a rough air speed, V_{RA}, for which there is a satisfactory service history, would be the basis for the new proposed § 25.1517. The FAA considers the level of safety provided in this notice to be the same as in the current rules.

Several changes are also proposed to other related rules to implement the new criteria and to consolidate the general gust requirements into a single section. Gust requirements are located in several different sections of part 25 that pertain to continuous turbulence, lateral gusts, etc. This proposal would consolidate many of these gust requirements into a revised § 25.341. In this regard, several changes to other sections are proposed to transfer requirements and to revise references to these requirements. These include the relocation of § 25.305(d) to § 25.341(b) and the transfer of §§ 25.331(a)(1) and 25.331(a)(2) to § 25.321 "General" and changing the title of § 25.331 to "Symmetric maneuvering conditions." Also the lateral gust requirements of § 25.351 would be removed since the proposed § 25.341 addresses both vertical and lateral gusts. The gust envelope would no longer be needed with the proposed criteria so it would be eliminated from § 25.333 and the title of this section would be changed to "Flight maneuvering envelope."

Changes are also proposed to adapt the tuned gust criteria to the cases of unsymmetrical loads in § 25.349 "rolling conditions," § 25.427 "Unsymmetrical loads," and to § 25.445 "Outboard fins." These rules would be revised in order to provide criteria for calculating unsymmetrical external airloads for dynamic discrete gust conditions and to provide for the effects of lateral gusts acting on auxiliary aerodynamic surfaces such as winglets and outboard fins. To be more general, it is proposed to change the title of § 25.445 from "Outboard fins" to "Auxiliary aerodynamic surfaces."

Regulatory Evaluation Summary

Preliminary Regulatory Evaluation, Initial Regulatory Flexibility Determination, and Trade Impact Assessment

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. In conducting these analyses, the FAA has determined that this rule: (1) Would generate benefits that justify its costs and is not a "significant regulatory action" as defined in the Executive Order; (2) is not significant as defined in DOT's Policies and Procedures; (3) would not have a significant impact on a substantial number of small entities; (4) would not constitute a barrier to international trade. These analyses, available in the docket, are summarized below.

Cost-Benefit Analysis

The proposed changes would have economic consequences. The costs would be the incremental costs of meeting the tuned discrete gust requirements rather than the current static discrete gust requirements. The benefits would be the savings from not meeting two different sets of discrete gust requirements, i.e., the requirements in the current FAR and the requirements in the JAR. In order to sell their transport category airplanes in a global marketplace, manufacturers usually certify their products under both sets of regulations. Harmonizing these discrete gust requirements would result in a net cost savings.

Industry sources provided information on the additional costs and cost savings that would result from the proposed rule. Based on this information a range of representative certification costs and savings are shown below. The costs and savings per certification are those related to meeting discrete gust load requirements, including related provisions of the proposed rule.

PER CERTIFICATION COSTS AND SAVINGS ASSOCIATED WITH PROPOSED DISCRETE GUST LOAD REQUIREMENTS

[In thousands of dollars]

Costs of current FAA certification	$29–$115
Costs of current JAA certification	70–145
Costs of current joint certification	100–150
Costs of proposed FAA certification	70–145
Costs of proposed joint certification	70–145
Savings (current joint certification costs minus proposed joint certification costs)	5–29

The costs and cost savings of specific certifications may vary from these estimates. In all cases where a manufacturer seeks both FAA and JAA certification, however, the cost savings realized through harmonizing the requirements would outweigh the expected incremental costs of the proposal. The FAA solicits information from manufacturers and other interested parties concerning the costs and savings associated with this proposal.

In addition to the cost savings expected from harmonization, the proposed rule would result in airplane designs that are based on more rational evaluations of conditions expected in flight.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by Federal regulations. The RFA requires A Regulatory Flexibility Analysis if a proposed rule would have "a significant economic impact on a substantial number of small entities." FAA Order 2100.14A outlines FAA's procedures and criteria for implementing the RFA.

An aircraft manufacturer must employ 75 or fewer employees to be designated as a "small" entity. A substantial number of small entities is defined as a number that is 11 or more and which is more than one-third of the small entities subject to a proposed or final rule. None of the manufacturers of transport category airplanes qualify as small entities under this definition. Therefore, the proposed rule would not have a significant economic impact on a substantial number of small entities.

International Trade Impact Assessment

The proposed rule would not constitute a barrier to international trade, including the export of American goods and services to foreign countries and the import of foreign goods and services into the United States. The discrete gust load requirements in this rule would harmonize with those of the

JAA and would, in fact, lessen the restraints on trade.

Federalism Implications

The regulations proposed herein would not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. Thus, in accordance with Executive Order 12612, it is determined that this proposal does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion: Because the proposed changes to the gust design criteria are not expected to result in a substantial economic cost, the FAA has determined that this proposed regulation would not be significant under Executive Order 12866. Because this is an issue that has not prompted a great deal of public concern, the FAA has determined that this action is not significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 25, 1979). In addition, since there are no small entities affected by this rulemaking, the FAA certifies that the rule, if promulgated, would not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act, since none would be affected. A copy of the regulatory evaluation prepared for this project may be examined in the Rules Docket or obtained from the person identified under the caption **FOR FURTHER INFORMATION CONTACT.**

List of Subjects in 14 CFR Part 25

Air transportation, Aircraft, Aviation safety, Safety, Gusts.

The Proposed Amendments

Accordingly, the Federal Aviation Administration (FAA) proposes to amend 14 CFR part 25 of the Federal Aviation Regulations (FAR) as follows:

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for Part 25 continues to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g), and 49 CFR 1.47(a).

§ 25.305 [Amended]

2. By amending § 25.305 by removing and reserving paragraph (d).

3. By amending § 25.321 by adding new paragraphs (c) and (d) to read as follows:

§ 25.321 General.

* * * * *

(c) Enough points on and within the boundaries of the design envelope must be investigated to ensure that the maximum load for each part of the airplane structure is obtained.

(d) The significant forces acting on the airplane must be placed in equilibrium in a rational or conservative manner. The linear inertia forces must be considered in equilibrium with the thrust and all aerodynamic loads, while the angular (pitching) inertia forces must be considered in equilibrium with thrust and all aerodynamic moments, including moments due to loads on components such as tail surfaces and nacelles. Critical thrust values in the range from zero to maximum continuous thrust must be considered.

4. By amending § 25.331 by revising the title and paragraph (a) to read as follows, and by removing and reserving paragraph (d).

§ 25.331 Symmetric maneuvering conditions.

(a) *Procedure.* For the analysis of the maneuvering flight conditions specified in paragraphs (b) and (c) of this section, the following provisions apply:

(1) Where sudden displacement of a control is specified, the assumed rate of control surface displacement may not be less than the rate that could be applied by the pilot through the control system.

(2) In determining elevator angles and chordwise load distribution in the maneuvering conditions of paragraph (b) and (c) of this section, the effect of corresponding pitching velocities must be taken into account. The in-trim and out-of-trim flight conditions specified in § 25.255 must be considered.

* * * * *

5. By amending § 25.333 by revising the title and paragraph (a) to read as follows, and by removing and reserving paragraph (c).

§ 25.333 Flight maneuvering envelope.

(a) *General.* The strength requirements must be met at each combination of airspeed and load factor on and within the boundaries of the representative maneuvering envelop (*V–n* diagram) of paragraph (b) of this section. This envelope must also be used in determining the airplane structural operating limitations as specified in § 25.1501.

* * * * *

6. By amending § 25.335 by revising paragraph (d) to read as follows:

§ 25.335 Design airspeeds.

* * * * *

(d) *Design speed for maximum gust intensity, V_B.*

(1) V_B may not be less than

$$V_{S1}=1+\left[\frac{K_g U_{ref} V_c a}{498w}\right]^{1/2}$$

where—

V_{S1}=the 1–g stalling speed based on C_{NAmax} with the flaps retracted at the particular weight under consideration;

V_c=design cruise speed (knots equivalent airspeed);

U_{ref}=the reference gust velocity (feet per second equivalent airspeed) from § 25.341(a)(5)(i);

w=average wing loading (pounds per square foot) at the particular weight under consideration.

$$K_g=\frac{.88\mu}{5.3+\mu}$$

$$\mu=\frac{2w}{\rho cag}$$

ρ=density of air (slugs/ft^3);

c=mean geometric chord of the wing (feet);

g=acceleration due to gravity (ft/sec^2);

a=slope of the airplane normal force coefficient curve, C_{NA} per radian;

(2) At altitudes where V_C is limited by Mach number—

(i) V_B may be chosen to provide an optimum margin between low and high speed buffet boundaries; and,

(ii) V_B need not be greater than V_C.

* * * * *

7. By revising § 25.341 to read as follows:

§ 25.341 Gust and turbulence loads.

(a) *Discrete Gust Design Criteria.* The airplane is assumed to be subjected to symmetrical vertical and lateral gusts in level flight. Limit gust loads must be determined in accordance with the following provisions:

(1) Loads on each part of the structure must be determined by dynamic analysis. The analysis must take into account unsteady aerodynamic characteristics and all significant structural degrees of freedom including rigid body motions.

(2) The shape of the gust must be:

$$U=\frac{U_{ds}}{2}\left[1-\mathrm{Cos}\left(\frac{\pi s}{H}\right)\right]$$

for $0 \le s \le 2H$

where—

s = distance penetrated into the gust (feet);

U_{ds} = the design gust velocity in equivalent airspeed specified in subparagraph (a)(4) of this paragraph; and

H = the gust gradient which is the distance (feet) parallel to the airplane's flight path for the gust to reach its peak velocity.

(3) A sufficient number of gust gradient distances in the range 30 feet to 350 feet must be investigated to find the critical response for each load quantity.

(4) The design gust velocity must be:

$$U_{ds} = U_{ref} F_g \left(\frac{H}{350} \right)^{1/6}$$

where—

U_{ref} = the reference gust velocity in equivalent airspeed defined in subparagraph (a)(5) of this paragraph.

F_g = the flight profile alleviation factor defined in subparagraph (a)(6) of this paragraph.

(5) The following reference gust velocities apply:

(i) At the airplane design speed V_C: Positive and negative gusts with reference gust velocities of 56.0 ft/sec EAS must be considered at sea level. The reference gust velocity may be reduced linearly from 56.0 ft/sec EAS at sea level to 44.0 ft/sec EAS at 15000 feet. The reference gust velocity may be further reduced linearly from 44.0 ft/sec EAS at 15000 feet to 26.0 ft/sec EAS at 50000 feet.

(ii) At the airplane design speed V_D: The reference gust velocity must be 0.5 times the value obtained under § 25.341(a)(5)(i).

(6) The flight profile alleviation factor, F_g, must be increased linearly from the sea level value to a value of 1.0 at the maximum operating altitude defined in § 25.1527. At sea level, the flight profile alleviation factor is determined by the following equation:

$$F_g = 0.5\left(F_{gz} + F_{gm}\right)$$

where –

$$F_{gz} = 1 - \frac{Z_{mo}}{250000};$$

$$F_{gm} = \sqrt{R_2 \mathrm{Tan}\left(\frac{\pi R_1}{4}\right)};$$

$$R_1 = \frac{\text{Maximum Landing Weight}}{\text{Maximum Take-off Weight}};$$

$$R_2 = \frac{\text{Maximum Zero Fuel Weight}}{\text{Maximum Take-off Weight}};$$

Z_{mo} = Maximum operating altitude defined in § 25.1527.

(7) When a stability augmentation system is included in the analysis, the effect of any significant system nonlinearities should be accounted for when deriving limit loads from limit gust conditions.

(b) *Continuous Gust Design Criteria.* The dynamic response of the airplane to vertical and lateral continuous turbulence must be taken into account. The continuous gust design criteria of Appendix G of this part must be used to establish the dynamic response unless more rational criteria are shown.

8. By amending § 25.343 by revising paragraph (b)(1)(ii) to read as follows:

§ 25.343 Design fuel and oil loads.

(b) * * *

(1) * * *

(ii) The gust conditions of § 25.341(a) but assuming 85% of the design velocities prescribed in § 25.341(a)(4).

* * * * *

9. By amending § 25.345 by revising paragraphs (a) and (c) to read as follows:

§ 25.345 High lift devices.

(a) If wing flaps are to be used during takeoff, approach, or landing, at the design flap speeds established for these stages of flight under § 25.335(e) and with the wing flaps in the corresponding positions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Maneuvering to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in § 25.341(a)(2) except that—

U_{ds} = 25 ft/sec EAS;

H = 12.5 c; and

c = mean geometric chord of the wing (feet).

* * * * *

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by—

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337(b); and

(2) The discrete vertical gust criteria in § 25.341(a).

* * * * *

10. By amending § 25.349 by revising the introductory text and paragraph (b) to read as follows:

§ 25.349 Rolling conditions.

The airplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reacting inertia forces.

* * * * *

(b) *Unsymmetrical gusts.* The airplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from § 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from § 25.341(a). It must be assumed that 100 percent of the wing air load acts on one side of the airplane and 80 percent of the wing air load acts on the other side.

11. By amending § 25.351 by revising the introductory text and by removing and reserving paragraph (b).

§ 25.351 Yawing Conditions.

The airplane must be designed for loads resulting from the conditions specified in paragraph (a) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces:

* * * * *

12. By revising § 25.371 to read as follows:

§ 25.371 Gyroscopic loads.

The structure supporting the engines and the auxiliary power units must be designed for the gyroscopic loads associated with the conditions specified in §§ 25.331, 25.341(a), 25.349 and 25.351 with the engine or auxiliary power units at maximum continuous rpm.

13. By amending § 25.373 by revising paragraph (a) to read as follows:

§ 25.373 Speed control devices.

* * * * *

(a) The airplane must be designed for the symmetrical maneuvers prescribed in § 25.333 and § 25.337, the yawing maneuvers prescribed in § 25.351, and the vertical and lateral gust conditions prescribed in § 25.341(a), at each setting and the maximum speed associated with that setting; and

* * * * *

14. By amending § 25.391 by revising the introductory text and paragraph (e) to read as follows:

§ 25.391 Control surface loads: general.

The control surfaces must be designed for the limit loads resulting from the flight conditions in §§ 25.331, 25.341(a), 25.349 and 25.351 and the ground gust conditions in § 25.415, considering the requirements for—

* * * * *

(e) Auxiliary aerodynamic surfaces, in § 25.445.

15. By revising § 25.427 to read as follows:

§ 25.427 Unsymmetrical loads.

(a) In designing the airplane for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100 percent of the maximum loading from the symmetrical maneuver conditions of § 25.331 and the vertical gust conditions of § 25.341(a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.

(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.

16. By amending § 25.445 by changing the title and revising paragraph (a) to read as follows:

§ 25.445 Auxiliary aerodynamic surfaces.

(a) When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw maneuvers, and gusts as specified in § 25.341(a) acting at any orientation at right angles to the flight path.

* * * * *

17. By amending § 25.571 by revising paragraphs (b)(2) and (3) to read as follows:

§ 25.571 Damage-tolerance and fatigue evaluation of structure.

* * * * *

(b) * * *

(2) The limit gust conditions specified in § 25.341 at the specified speeds up to V_C and in § 25.345.

(3) The limit rolling conditions specified in § 25.349 and the limit unsymmetrical conditions specified in §§ 25.367 and 25.427 (a) through (c), at speeds up to V_C.

* * * * *

18. By adding a new § 25.1517 to read as follows:

§ 25.1517 Rough air speed, V_{RA}.

A rough air speed, V_{RA}, for use as the recommended turbulence penetration airspeed in § 25.1585(a)(8), must be established, which—

(1) is not greater than the design airspeed for maximum gust intensity, selected for V_B; and

(2) is not less than the minimum value of V_B specified in § 25.335(d); and

(3) is sufficiently less than V_{MO} to ensure that likely speed variation during rough air encounters will not cause the overspeed warning to operate too frequently. In the absence of a rational investigation substantiating the use of other values, V_{RA} must be less than V_{MO}—35 knots (TAS).

Issued in Washington, DC, on September 8, 1994.

Thomas E. McSweeny,

Director, Aircraft Certification Service.

[FR Doc. 94–22903 Filed 9–15–94; 8:45 am]

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. 27902; Amdt. No. 25–86]

RIN 2120–AF27

Revised Discrete Gust Load Design Requirements

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This amendment revises the gust load design requirements for transport category airplanes. This amendment replaces the current discrete gust requirement with a new requirement for a discrete tuned gust; modifies the method of establishing the design airspeed for maximum gust intensity; and provides for an operational rough air speed. These changes are made in order to provide a more rational basis of accounting for the aerodynamic and structural dynamic characteristics of the airplane. These changes also provide for harmonization of the discrete gust requirements with the Joint Aviation Requirements (JAR) of Europe as recently amended.

EFFECTIVE DATE: March 11, 1996.

FOR FURTHER INFORMATION CONTACT: James Haynes, Airframe and Propulsion Branch, ANM–112, Transport Airplane Directorate, Aircraft Certification Service, FAA, 1601 Lind Avenue SW., Renton, WA 98055–4056; telephone (206) 227–2131.

SUPPLEMENTARY INFORMATION:

Background

The National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA), began an inflight gust measurement program in 1933 to assist in the refinement of gust load design criteria. Using unsophisticated analog equipment, that program resulted in the development of the improved design requirements for gust loads that were issued in part 04 of the Civil Aeronautics Regulations (CAR) in the 1940's. The corresponding Civil Aeronautics Manual (CAM) 04 provided a simplified formula from which to derive the design gust loads from the specified design gust velocities. These criteria were based on an analytical encounter of the airplane with a discrete ramp-shaped gust with a gradient distance (the distance necessary for the gust to build to a peak) of 10 times the mean chord length of the airplane wing. An alleviation factor, calculated from wing loading, was provided in order to account for the relieving effects of rigid body motion of the airplane as it penetrated the gust. With the development of the VGH (velocity, load factor, height) recorder in 1946, NASA began collecting a large quantity of gust load data on many types of aircraft in airline service. Although that program was terminated for transport airline operations in 1971, the data provided additional insight into the nature of gusts in the atmosphere, and resulted in significant changes to the gust load design requirements. The evolution of the discrete gust design criteria from part 04 through part 4b of the CAR to current part 25 of Title 14 of the Code of Federal Regulations (CFR) (which contains the design requirements for transport category airplanes) resulted in the establishment of a prescribed gust shape with a specific gust gradient distance and increased peak gust design velocities. The prescribed shape was a "one-minus-cosine" gust shape with a specified gust gradient distance of 12.5 times the mean chord length of the airplane wing. The gust gradient distance, for that particular shape, was equal to one-half the total gust length. A simplified analytical method similar to the methodology of CAM 04 was provided along with an improved alleviation factor that accounted for unsteady aerodynamic forces, gust shape, and the airplane rigid body vertical response.

The increasing speed, size, and structural flexibility of transport airplanes resulted in the need to consider not only the rigid body response of the airplane, but also structural dynamic response and the effects of structural deformation on the aerodynamic parameters. Early attempts to account for structural flexibility led to a "tuned" gust approach in which the analysis assumed a flexible airplane encountering gusts with various gradient distances in order to find the most critical gust gradient distance for use in design for each major component. A tuned discrete gust approach became a requirement for compliance with the British Civil Airworthiness Requirements.

Another method of accounting for the structural dynamic effects of the airplane involved the power spectral density (PSD) analysis technique which accounted for the statistical distribution of gusts in continuous turbulence in conjunction with the aeroelastic and structural dynamic characteristics of the airplane. In the 1960's, the Federal Aviation Administration (FAA) awarded study contracts to Boeing and Lockheed for the purpose of assisting the FAA in developing the PSD gust methodology into continuous gust design criteria with analytical procedures. The final PSD continuous turbulence criteria were based on those studies and were codified in Appendix G to part 25 in 1980.

Recognizing that the nature of gusts was not completely defined, and that individual discrete gusts might exist outside the normal statistical distribution of gusts in continuous turbulence, the FAA retained the existing criteria for discrete gusts in addition to the new requirement for continuous turbulence. The current discrete gust criteria in Subpart C of part 25 require the loads to be analytically developed assuming the airplane encounters a gust with a fixed gradient distance of 12.5 mean chord lengths. For application of the current criteria, it is generally assumed that the airplane is rigid in determining the dynamic response to the gust while the effects of wing elastic deflection on wing static lift parameters are normally taken into account. The minimum value of the airplane design speed for maximum gust intensity, V_B, is also established from the discrete gust criteria.

Recent flight measurement efforts by FAA and NASA have been aimed at utilizing measurements from the digital flight data recorders (DFDR) to derive gust load design information for airline transport airplanes. The Civil Aviation Authority (CAA) of the United Kingdom has also been conducting a comprehensive DFDR gust measurement program for transport airplanes in airline service. The program, called CAADRP (Civil Aircraft Airworthiness Data Recording Program), uses data sampling rates that allow the measurement of a wide range of gust gradient distances. The CAADRP program is still continuing and has resulted in an extensive collection of reliable gust data.

In 1988, the FAA, in cooperation with the JAA and organizations representing the American and European aerospace industries, began a process to harmonize the airworthiness requirements of the United States and the airworthiness requirements of Europe in regard to gust requirements. The objective was to achieve common requirements for the certification of transport airplanes without a substantive change in the level of safety provided by the regulations. Other airworthiness authorities such as Transport Canada have also participated in this process.

In 1992, the harmonization effort was undertaken by the Aviation Regulatory Advisory Committee (ARAC). A working group of industry and

DEPARTMENT OF TRANSPORTATION

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EFFECTIVE DATE: March 11, 1996.

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The increasing speed, size, and structural flexibility of transport airplanes resulted in the need to consider not only the rigid body response of the airplane, but also structural dynamic response and the effects of structural deformation on the aerodynamic parameters. Early attempts to account for structural flexibility led to a "tuned" gust approach in which the analysis assumed a flexible airplane encountering gusts with various gradient distances in order to find the most critical gust gradient distance for use in design for each major component. A tuned discrete gust approach became a requirement for compliance with the British Civil Airworthiness Requirements.

Another method of accounting for the structural dynamic effects of the airplane involved the power spectral density (PSD) analysis technique which accounted for the statistical distribution of gusts in continuous turbulence in conjunction with the aeroelastic and structural dynamic characteristics of the airplane. In the 1960's, the Federal Aviation Administration (FAA) awarded study contracts to Boeing and Lockheed for the purpose of assisting the FAA in developing the PSD gust methodology into continuous gust design criteria with analytical procedures. The final PSD continuous turbulence criteria were based on those studies and were codified in Appendix G to part 25 in 1980.

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In 1988, the FAA, in cooperation with the JAA and organizations representing the American and European aerospace industries, began a process to harmonize the airworthiness requirements of the United States and the airworthiness requirements of Europe in regard to gust requirements. The objective was to achieve common requirements for the certification of transport airplanes without a substantive change in the level of safety provided by the regulations. Other airworthiness authorities such as Transport Canada have also participated in this process.

In 1992, the harmonization effort was undertaken by the Aviation Regulatory Advisory Committee (ARAC). A working group of industry and government structural loads specialists of Europe, the United States, and Canada was chartered by notice in the **Federal Register** (58 FR 13819, March 15, 1993) to harmonize certain specific sections of part 25, including the requirements related to discrete gusts. The harmonization task concerning discrete gusts was completed by the working group and recommendations were submitted to FAA by letter dated October 15, 1993. The FAA concurred with the recommendations and proposed them in Notice of Proposed Rulemaking (NPRM) No. 94–29 which was published in the **Federal Register** on September 16, 1994, (59 FR 47756).

Discussion of Comments

Comments were received from domestic and foreign aviation manufacturers and foreign airworthiness authorities. The majority of the commenters agreed with the proposal and recommended its adoption. However, some commenters disagreed substantially with the proposal while providing alternative proposals that appeared to merit further consideration by the Aviation Rulemaking Advisory Committee. Therefore the FAA tasked the ARAC Loads and Dynamics Working Group by notice in the **Federal Register** (60 FR 18874, April 13, 1995) to consider the comments and provide recommendations for the disposition of the comments along with any recommendations for changes to the proposal. The disposition of comments that follows is based on the recommendation submitted to the FAA by ARAC on July 14, 1995.

One commenter suggests that the new method for calculating the minimum V_B results in lower values at altitude than the current method provided in the Joint Aviation Requirements (JAR) and could provide unrealistic margins above the stalling speed. The FAA disagrees. The commenter provides no data or other information that shows the new V_B calculations to be unrealistic. The new method for calculating the minimum V_B is approximately the same as in the current FAR and JAR; the main difference being that revised gust speeds are used in the calculation. These gust speeds are based on actual measurements in aircraft operation and are considered to result in a realistic and conservative V_B speed, even if it is somewhat lower than the current requirements at some altitudes. In addition, a new operational rough air speed, V_{RA}, is provided in order to ensure adequate stall margins while operating in rough air. As part of the effort to harmonize the airworthiness requirements, the JAA is also considering adopting this method of calculating the minimum V_B speeds. This commenter, along with several other, also points out an error in the formula for the design speed for maximum gust intensity, V_B, in § 25.335(d) and this error has been corrected.

One commenter suggests that the proposed tuned gust criteria do not fully account for the dynamic response of the airplane and therefore could produce unconservative results and seriously underpredict the gust design loads. The commenter suggests that the proposal be replaced by an entirely new method of accounting for discrete gusts. This method is known in the industry as the statistical discrete gust method (SDG). In response to the task defined in the **Federal Register**, the ARAC Loads and Dynamics Working Group considered the commenters comments and the alternate proposal in considerable detail. It is recognized by the working group that the current proposed tuned gust criteria have some limitations and that the suggested SDG method may have some promising applications for predicting gust loads. However, the SDG method is in a developmental stage, and there is currently no established industry process for using this method in predicting gust design loads. The FAA will retain the commenters proposal for possible consideration in future rulemaking actions. In response to the commenters specific concerns, neither ARAC nor the FAA agree that the tuned gust method will result in unconservative design loads. In addition, for the extreme gust gradient distances where the commenter questions the adequacy of the tuned gust method to fully account for dynamic response, the FAA considers that the additional continuous gust criteria of § 25.341(b) will compensate for any possible deficiencies. The commenter provides some comparisons of loads produced by the SDG method with the results of the proposed tuned gust method. These results show no significant differences in overall load levels when all factors are considered, and in some cases the SDG method actually provided lower design loads. Therefore, except for an editorial correction to the mathematical equation noted above, the amendment is adopted as proposed.

Regulatory Evaluation Summary

Regulatory Evaluation, Regulatory Flexibility Determination, and Trade Impact Assessment

Changes to federal regulations must undergo several economic analyses. First, Executive Order 12866 directs Federal agencies to promulgate new regulations or modify existing regulations only if the potential benefits to society justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Finally, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. In conducting these assessments, the FAA has determined that this rule: (1) will generate benefits exceeding its costs and is not "significant" as defined in Executive Order 12866; (2) is not "significant" as defined in DOT's Policies and Procedures; (3) will not have a significant impact on a substantial number of small entities; and (4) will not constitute a barrier to international trade. These analyses, available in the docket, are summarized below.

Costs and Benefits

The changes will have economic consequences. The costs will be the incremental costs of meeting the tuned discrete gust requirements rather than the current static discrete gust requirements. The benefits will be the cost savings from not meeting two different sets of discrete gust requirements, i.e., the requirements in the current FAR and the requirements in the JAR. In order to sell their transport category airplanes in a global marketplace, manufacturers usually certify their products under both sets of regulations.

Industry sources provided information on the additional costs and cost savings that would result from the rule. Based on this information, a range of representative certification costs and savings are shown below. The costs and savings per certification are those related to meeting discrete gust load requirements, including related provisions of the final rule.

PER CERTIFICATION COSTS AND SAVINGS ASSOCIATED WITH REVISED DISCRETE GUST LOAD REQUIREMENTS

[In thousands of dollars]

Current FAA certification requirement costs	$29–$115
Current JAA certification requirement costs	$70–$145
Current joint certification requirement costs	$100–$150
Revised FAA certification requirement costs	$70–$145

PER CERTIFICATION COSTS AND SAVINGS ASSOCIATED WITH REVISED DISCRETE GUST LOAD REQUIREMENTS—Continued

[in thousands of dollars]

Revised joint certification requirement costs	$70–$145
Savings (current joint certification costs minus revised joint certification costs)	$5–$30

The costs and cost savings of specific certifications may vary from these estimates. In all cases where a manufacturer seeks both FAA and JAA certification, however, the cost savings realized through harmonized requirements will outweigh the expected incremental costs of the rule. The FAA did not receive comments concerning this quantification of costs during the comment period; therefore, the FAA holds that these are representative costs and savings.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by Federal regulations. The RFA requires agencies to review rules which may have "a significant economic impact on a substantial number of small entities." FAA Order 2100.14A outlines FAA's procedures and criteria for implementing the RFA.

An aircraft manufacturer must employ 75 or fewer employees to be designated as a "small" entity. A substantial number of small entities is defined as a number that is 11 or more and which is more than one-third of the small entities subject to a proposed or final rule. None of the manufacturers of transport category airplanes qualify as small entities under this definition. Therefore, the final rule will not have a significant economic impact on a substantial number of small entities.

International Trade Impact Assessment

The rule will not constitute a barrier to international trade, including the export of American goods and services to foreign countries and the import of foreign goods and services into the United States. The discrete gust load requirements in this rule will harmonize with those of the JAA and will, in fact, lessen the restraints on trade.

Federalism Implications

The regulations proposed herein would not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various level of government. Thus, in accordance with Executive Order 12612, it is determined that this proposal does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

Because the proposed changes to the gust design criteria are not expected to result in a substantial economic cost, the FAA has determined that this proposed regulation would not be significant under Executive Order 12866. Because this is an issue that has not promoted a great deal of public concern, the FAA has determined that this action is not significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 25, 1979). In addition, since there are no small entities affected by this rulemaking, the FAA certifies that the rule would not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act, since none would be affected. A copy of the regulatory evaluation prepared for this project may be examined in the Rules Docket or obtained fro the person identified under the caption **FOR FURTHER INFORMATION CONTACT.**

List of Subjects in 14 CFR Part 25

Air transportation, Aircraft, Aviation safety, Safety, Gusts.

The Amendments

In consideration of the foregoing, the Federal Aviation Administration (FAA) amends 14 CFR Part 25 of the Federal Aviation Regulations (FAR) as follows:

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for part 25 is revised to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702 and 44704.

§ 25.305 [Amended]

2. By amending § 25.305 by removing and reserving paragraph (d).

3. By amending § 25.321 by adding new paragraphs (c) and (d) to read as follows:

§ 25.321 General.

* * * * *

(c) Enough points on and within the boundaries of the design envelope must be investigated to ensure that the maximum load for each part of the airplane structure is obtained.

(d) The significant forces acting on the airplane must be placed in equilibrium in a rational or conservative manner. The linear inertia forces must be considered in equilibrium with the thrust and all aerodynamic loads, while the angular (pitching) inertia forces must be considered in equilibrium with thrust and all aerodynamic moments, including moments due to loads on components such as tail surfaces and nacelles. Critical thrust values in the range from zero to maximum continuous thrust must be considered.

4. By amending § 25.331 by revising the title and paragraph (a) introductory text, by removing paragraphs (a) (1) and (2) and redesignating paragraphs (a) (3) and (4) as (a) (1) and (2) respectively and revising them to read as set forth below, and by removing paragraph (d).

§ 25.331 Symmetric maneuvering conditions.

(a) *Procedure.* For the analysis of the maneuvering flight conditions specified in paragraphs (b) and (c) of this section, the following provisions apply:

(1) Where sudden displacement of a control is specified, the assumed rate of control surface displacement may not be less than the rate that could be applied by the pilot through the control system.

(2) In determining elevator angles and chordwise load distribution in the maneuvering conditions of paragraphs (b) and (c) of this section, the effect of corresponding pitching velocities must be taken into account. The in-trim and out-of-trim flight conditions specified in § 25.255 must be considered.

* * * * *

5. By amending § 25.333 by revising the title and paragraph (a) to read as follows, and by removing paragraph (c).

§ 25.333 Flight maneuvering envelope.

(a) *General.* The strength requirements must be met at each combination of airspeed and load factor on and within the boundaries of the representative maneuvering envelope (*V-n* diagram) of paragraph (b) of this section. This envelope must also be used in determining the airplane structural operating limitations as specified in § 25.1501.

* * * * *

6. By amending § 25.335 by revising paragraph (d) to read as follows:

§ 25.335 Design airspeeds.

* * * * *

(d) *Design speed for maximum gust intensity, V_B.*

(1) V_B may not be less than

$$V_{S1}\left[1+\frac{K_g U_{ref} V_c a}{498w}\right]^{1/2}$$

where—

V_{S1}=the 1-g stalling speed based on C_{NAmax} with the flaps retracted at the particular weight under consideration;

V_c=design cruise speed (knots equivalent airspeed);

U_{ref}=the reference gust velocity (feet per second equivalent airspeed) from § 25.341(a)(5)(i);

w=average wing loading (pounds per square foot) at the particular weight under consideration.

$$K_g=\frac{.88\mu}{5.3+\mu}$$

$$\mu=\frac{2w}{\rho cag}$$

ρ=density of air (slugs/ft^3);

c=mean geometric chord of the wing (feet);

g=acceleration due to gravity (ft/sec^2);

a=slope of the airplane normal force coefficient curve, C_{NA} per radian;

(2) At altitudes where V_C is limited by Mach number—

(i) V_B may be chosen to provide an optimum margin between low and high speed buffet boundaries; and,

(ii) V_B need not be greater than V_C.

* * * * *

7. By revising § 25.341 to read as follows:

§ 25.341 Gust and turbulence loads.

(a) *Discrete Gust Design Criteria.* The airplane is assumed to be subjected to symmetrical vertical and lateral gusts in level flight. Limit gust loads must be determined in accordance with the provisions:

(1) Loads on each part of the structure must be determined by dynamic analysis. The analysis must take into account unsteady aerodynamic characteristics and all significant structural degrees of freedom including rigid body motions.

(2) The shape of the gust must be:

$$U=\frac{U_{ds}}{2}\left[1-\mathrm{Cos}\left(\frac{\pi s}{H}\right)\right]$$

for $0 \leq s \leq 2H$

where—

s=distance penetrated into the gust (feet);

U_{ds}=the design gust velocity in equivalent airspeed specified in paragraph (a)(4) of this section; and

H=the gust gradient which is the distance (feet) parallel to the airplane's flight path for the gust to reach its peak velocity.

(3) A sufficient number of gust gradient distances in the range 30 feet to 350 feet must be investigated to find the critical response for each load quantity.

(4) The design gust velocity must be:

$$U_{ds}=U_{ref}F_g\left(\frac{H}{350}\right)^{1/6}$$

where—

U_{ref}=the reference gust velocity in equivalent airspeed defined in paragraph (a)(5) of this section.

F_g=the flight profile alleviation factor defined in paragraph (a)(6) of this section.

(5) The following reference gust velocities apply:

(i) At the airplane design speed V_C: Positive and negative gusts with reference gust velocities of 56.0 ft/sec EAS must be considered at sea level. The reference gust velocity may be reduced linearly from 56.0 ft/sec EAS at sea level to 44.0 ft/sec EAS at 15000 feet. The reference gust velocity may be further reduced linearly from 44.0 ft/sec EAS at 15000 feet to 26.0 ft/sec EAS at 50000 feet.

(ii) At the airplane design speed V_D: The reference gust velocity must be 0.5 times the value obtained under § 25.341(a)(5)(i).

(6) The flight profile alleviation factor, F_g, must be increased linearly from the sea level value to a value of 1.0 at the maximum operating altitude defined in § 25.1527. At sea level, the flight profile alleviation factor is determined by the following equation:

$$F_g=0.5\left(F_{gz}+F_{gm}\right)$$

Where:

$$F_{gm}=1-\frac{Z_{mo}}{250000};$$

$$F_{gm}=\sqrt{R_2\mathrm{Tan}\left(\pi R_1/4\right)};$$

$$R_1=\frac{\text{Maximum Landing Weight}}{\text{Taximum Take-off Weight}};$$

$$R_2=\frac{\text{Maximum Zero Fuel Weight}}{\text{Maximum Take-off Weight}};$$

Z_{mo}=Maximum operating altitude defined in § 25.1527.

(7) When a stability augmentation system is included in the analysis, the effect of any significant system nonlinearities should be accounted for when deriving limit loads from limit gust conditions.

(b) *Continuous Gust Design Criteria.* The dynamic response of the airplane to vertical and lateral continuous turbulence must be taken into account. The continuous gust design criteria of Appendix G of this part must be used to establish the dynamic response unless more rational criteria are shown.

8. By amending § 25.343 by revising paragraph (b)(1)(ii) to read as follows:

§ 25.343 Design fuel and oil loads.

(a) * * *

(b) * * *

(1) * * *

(ii) The gust conditions of § 25.341(a) but assuming 85% of the design velocities prescribed in § 25.341(a)(4).

* * * * *

9. By amending § 25.345 by revising paragraphs (a) and (c) to read as follows:

§ 25.345 High lift devices.

(a) If wing flaps are to be used during takeoff, approach, or landing, at the design flap speeds established for these stages of flight under § 25.335(e) and with the wing flaps in the corresponding positions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Maneuvering to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in § 25.341(a)(2) except that—

U_{ds}=25 ft/sec EAS;

H=12.5 c; and

c=mean geometric chord of the wing (feet).

(b) * * *

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by—

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337(b); and

(2) The discrete vertical gust criteria in § 25.341(a).

* * * * *

10. By amending § 25.349 by revising the introductory text and paragraph (b) to read as follows:

§ 25.349 Rolling conditions.

The airplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reaching inertia fores.

(a) * * *

(b) *Unsymmetrical gusts.* The airplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from § 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from § 25.341(a). It must be assumed that 100 percent of the wing air load acts on one side of the airplane and 80 percent of the wing air load acts on the other side.

11. By amending § 25.351 by revising the introductory text and by removing and reserving paragraph (b).

§ 25.351 Yawing conditions.

The airplane must be designed for loads resulting from the conditions specified in paragraph (a) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces:

* * * * *

12. By revising § 25.371 to read as follows:

§ 25.371 Gyroscopic loads.

The structure supporting the engines and the auxiliary power units must be designed for the gyroscopic loads associated with the conditions specified in §§ 25.331, 25.341(a), 25.349 and 25.351 with the engine or auxiliary power units at maximum continuous rpm.

13. By amending § 25.373 by revising paragraph (a) to read as follows:

§ 25.373 Speed control devices.

* * * * *

(a) The airplane must be designed for the symmetrical maneuvers prescribed in § 25.333 and § 25.337, the yawing maneuvers prescribed in § 25.351, and the vertical and later gust conditions prescribed in § 25.341(a), at each setting and the maximum speed associated with that setting; and

* * * * *

14. By amending § 25.391 by revising the introductory text and paragraph (e) to read as follows:

§ 25.391 Control surface loads: general.

The control surfaces must be designed for the limit loads resulting from the flight conditions in §§ 25.331, 25.341(a), 25.349 and 25.351 and the ground gust conditions in § 25.415, considering the requirements for—

* * * * *

(e) Auxiliary aerodynamic surfaces, in § 25.445.

15. By revising § 25.427 to read as follows:

§ 25.427 Unsymmetrical loads.

(a) In designing the airplane for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100 percent of the maximum loading from the symmetrical maneuver conditions of § 25.331 and the vertical gust conditions of § 25.341(a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.

(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.

16. By amending § 25.445 by revising the title and revising paragraph (a) to read as follows:

§ 25.445 Auxiliary aerodynamic surfaces.

(a) When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw maneuvers, and gusts as specified in § 25.341(a) acting at any orientation at right angles to the flight path.

* * * * *

17. By amending § 25.571 by revising paragraphs (b)(2) and (b)(3) to read as follows:

§ 25.571 Damage-tolerance and fatigue evaluation of structure.

* * * * *

(b) * * *

(2) The limit gust conditions specified in § 25.341 at the specified speeds up to V_C and in § 25.345.

(3) The limit rolling conditions specified in § 25.349 and the limit unsymmetrical conditions specified in §§ 25.367 and 25.427 (a) through (c), at speeds up to V_C.

* * * * *

18. By adding a new § 25.1517 to read as follows:

§ 25.1517 Rough air speed, V_{RA}.

A rough air speed, V_{RA}, for use as the recommended turbulence penetration airspeed in § 25.1585(a)(8), must be established, which—

(1) Is not greater than the design airspeed for maximum gust intensity, selected for V_B; and

(2) Is not less than the minimum value of V_B specified in § 25.335(d); and

(3) Is sufficiently less than V_{MO} to ensure that likely speed variation during rough air encounters will not cause the overspeed warning to operate too frequently. In the absence of a rational investigation substantiating the use of other values, V_{RA} must be less than V_{MO}—35 knots (TAS).

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David R. Hinson,

Administrator.

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